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NATIONAL BUREAU OF STANDARDS

July/1969

Technical News Bulletin

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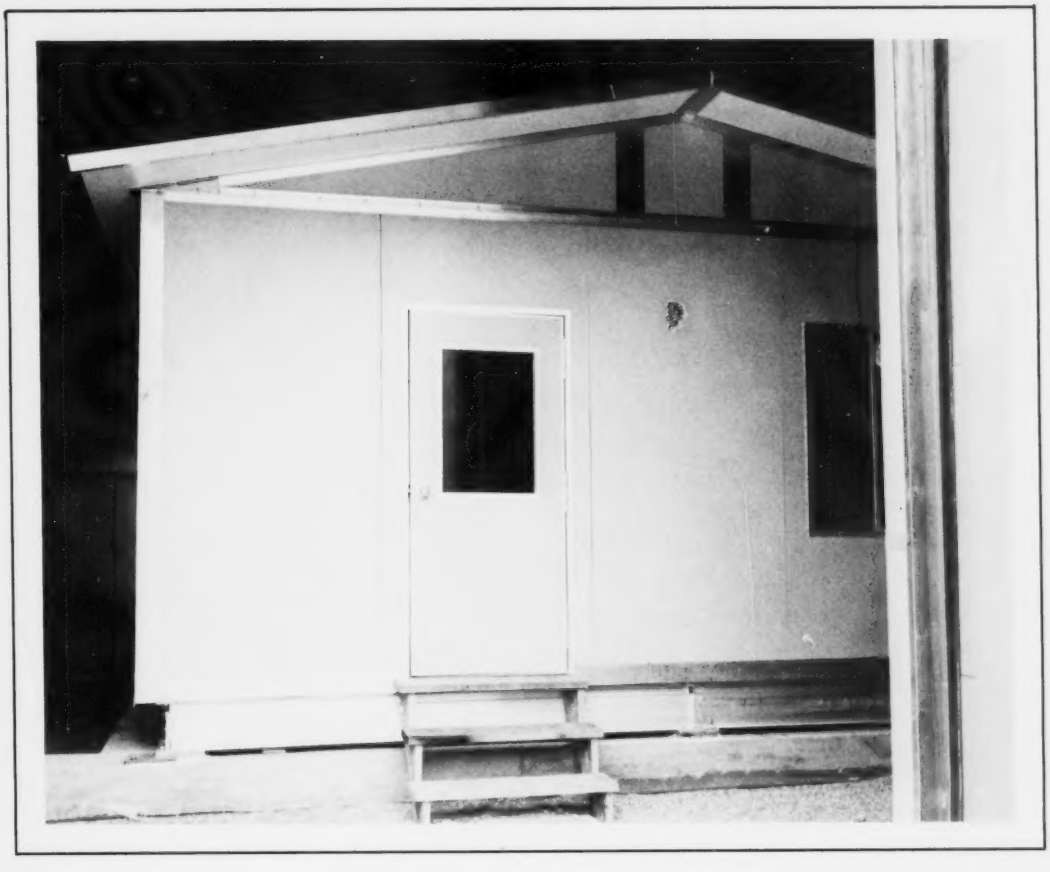

U.S. DEPARTMENT OF COMMERCE

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NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

JULY 1969/VOL. 53, NO. 7/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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COVER: A building within a building. Erected inside the Bureau's environmental test chamber, the performance of this prefabricated building is being evaluated for the Navy. *(See page 154.)*

Prepared by the NBS Office of Technical Information and Publications, Washington, D.C. 20234

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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CHROMIUM COMPOUND FOUND FERROMAGNETIC

A chromium-beryllium compound, $CrBe_{12}$, has been found to be ferromagnetic. N. M. Wolcott pulls a $CrBe_{12}$ sample from a coil, immersed in liquid helium, to measure its magnetic moment.

A NEW CHROMIUM COMPOUND was recently found to be ferromagnetic in a study[1] at the NBS Institute for Materials Research. While investigating ferromagnetism, superconductivity, and diamagnetism in beryllium and some of its compounds, N. M. Wolcott and R. L. Falge, Jr., of the Institute's Metallurgy Division discovered that $CrBe_{12}$ is ferromagnetic below 50 K.

This discovery was unexpected for two reasons. First, chromium compounds are usually antiferromagnetic, as for example chromium-iron compounds where the chromium decreases the magnetic moment of the iron. Secondly, the only beryllium compounds known to be ferromagnetic are the beryllium-iron compounds, $FeBe_2$ and $FeBe_5$.

While studying $CrBe_{12}$, Drs. Wolcott and Falge found that this compound has a Curie point of about 50 K. Above that temperature, the material is paramagnetic, i.e., the magnetic moments of the atoms are not alined. Below 50 K the material exhibits a weak ferromagnetic moment with hysteresis. Remanence (the retention of magnetism after the external magnetic field is removed) was observed in the temperature region below the Curie point. The distance between the chromium atoms in the ferromagnetic $CrBe_{12}$ is 4.18 Å, while in chromium metal the atoms are 2.5 Å apart and the ordering is antiferromagnetic.

As its apparent moment in the paramagnetic state above the Curie point is almost 7½ times as large as the saturation moment in the ferromagnetic state, the NBS investigators concluded that $CrBe_{12}$ may be one of the new "itinerant" ferromagnets. An "itinerant" ferromagnet is one in which the magnetic moment is distributed among the conduction electrons, instead of being localized around atomic sites as is the case in a normal or "localized" ferromagnet.

Ferromagnetism is a phenomenon of some solids in which all the magnetic moments of the atoms are alined in the same direction, producing an overall magnetic moment for the solid. Many common materials can be magnetized; that is, they have within them domains or regions where the atomic moments are all parallel. By placing such a material in a magnetic field these domains are easily alined producing an overall magnetization. When the field is removed a net magnetization may remain. Materials possessing such domains are called ferromagnets. Iron, nickel, and cobalt are typical ferromagnetic materials.

Once magnetized, ferromagnetic materials will retain their magnetic properties until the alinement of the atomic magnetic moments is disturbed. One disturbing effect is temperature. As temperature increases, the motion of the atoms increases (thermal agitation) and their alinement within each domain decreases, thereby reducing the solid's magnetic moment. The temperature at which thermal agitation becomes so great that the alinement of the magnetic moments of the atoms is completely random is called the Curie temperature, or Curie point. Above this point the material is no longer ferromagnetic. Domains no longer exist but a weaker kind of magnetism is present, called paramagnetism. Paramagnets do not retain their magnetization when the magnetizing field is removed.

Another group of materials, called antiferromagnets, appear to have no magnetic moment. This lack of magnetic moment is caused by the alinement of atoms with equal magnetic moments in opposite directions. Chromium and chromium compounds usually fall in this antiferromagnetic group. Thus, the ferromagnetic $CrBe_{12}$ is considered unusual.

[1] Wolcott, N. M., and Falge, R. L., Jr., Ferromagnetism of $CrBe_{12}$, Phys. Rev. **173**, No. 2, 591–595 (July 1968).

ANALOG DATA VIA TELETYPEWRITER

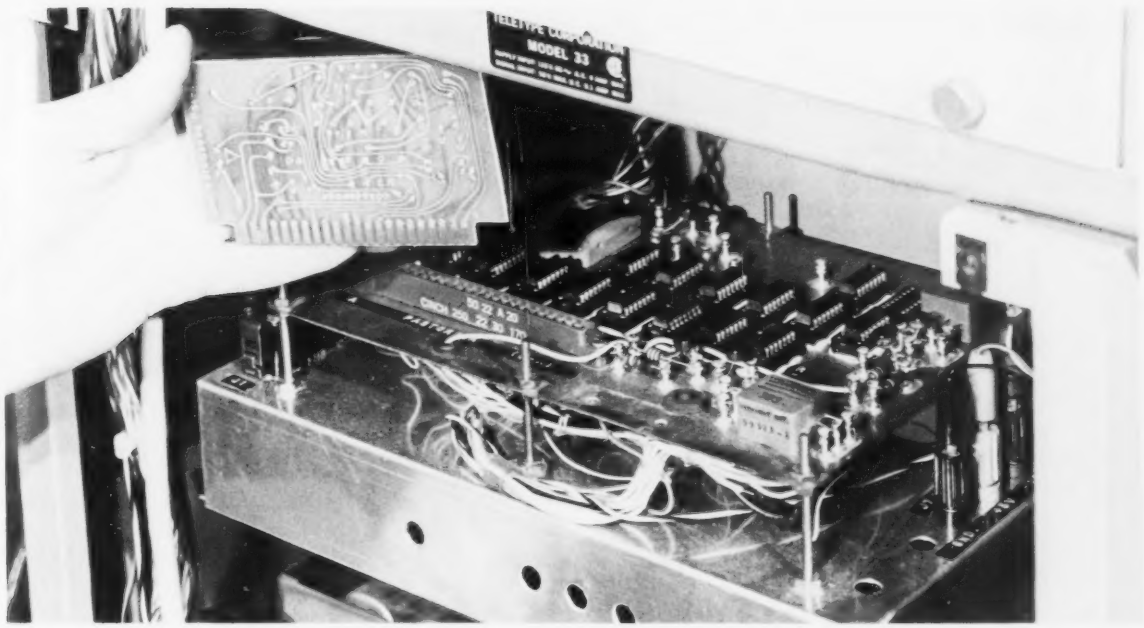
NBS Terminal Plots Waveforms

A TELETYPE TERMINAL MODIFICATION designed at the NBS Center for Computer Sciences and Technology by Louis J. Palombo drives a stripchart to produce a plot of analog data. This modification to a standard teletypewriter terminal resulted from a research and development program sponsored by the Advanced Research Projects Agency of the Department of Defense. The original application of the modified terminal was to enable personnel at a geophysical data collection center to monitor up-to-the-minute plots of analog data originating at remote sensors. Such data can be more easily operated on by computers—for storage, transmission, and retrieval—if encoded in digital form. This device enables the computer user to reconstitute archival analog material or to compare an input plot with features of stored ones.

Recent advances in practice have enabled more people to use computers, largely by means of remote terminals and systems for sharing computer time. Such systems are for digital data only; the user of analog data must convert them into digital form before putting them into the system. Needed, therefore, are accessory devices for returning the data to their original analog form.

The NBS waveform receiving system consists of the regular teletypewriter and the data set coupler connecting it

Louis Palombo inspects waveform on a stripchart reproduced by a modification he devised for the teletypewriter.



The waveform receiver as it is mounted on a shelf beneath its teletypewriter.

to the telephone line, to which are added the waveform receiver designed at the Bureau, its power supply, and a stripchart recorder. The added components can be mounted on the teletypewriter pedestal.

The modified teletypewriter terminal can be set to receive normal messages, via the waveform receiver. When a PLOT command is received in the string of incoming characters the machine stops printing and the stripchart transport starts up. The incoming characters move the stripchart pen to successive positions on a 250-position scale, producing a plot as the chart unrolls. When a PRINT command arrives at the waveform receiver the recorder stops and the teletypewriter returns to its normal operation.

The teletypewriter uses the USASCII (USA Standard Code for Information Interchange) [1] character code, which has seven bits for character identification and one for parity check—an internal error-checking procedure. All eight bits are used in giving the analog values, less the characters needed for mode instructions, PLOT and PRINT.

Receiver Circuitry

Most of the components of the waveform receiver are mounted on a 6-by-9 inch etched circuit board on top of a chassis. The chassis is placed on a shelf at the rear of the teletypewriter stand, with shafts for its gain and zero controls protruding through holes to the front of the stand. The function switch and the reset switch, which complete the receiver circuitry, are mounted in front, under the recorder.

The receiver circuitry makes extensive use of packaged integrated circuits. Used are 10 dual J-K flip-flop multivibrators, 4 quadruple 2-input NAND gates, a dual 4-input NAND gate, 2 8-input NAND gates, and a digital-to-analog converter.

An 880-Hz tuning fork originates the timing pulses that control picking up the serial data for each word or pen position in the signal from the data set coupler. When the receiver is in the PRINT mode, character data go from the control section to the shift register, which is driven at a 110-Hz rate derived from the 880-Hz clock. The parallel data emerging from the shift register go through the character detector and, by appropriate relays, to the teletypewriter.

When the receiver is in the PLOT mode, pen position data go directly from the control section to the digital-to-analog converter. The resulting analog signals go via the relays to the stripchart drive and pen.

When used in the PRINT mode the waveform receiver accommodates the 10 character-per-second rate at which the system operates. It will accept and mark plot positions at that rate also, although analog data to date have been sensed only at lower rates. The system is designed to reproduce relatively static and slow-changing waveforms.

[1] President approves Federal adp standards. USASCII to extend compatibility, NBS Tech. News Bull. **52**, 173 (Aug. 1968).

In progress . . .

PREFABRICATED BUILDING UNDERGOES EVALUATION

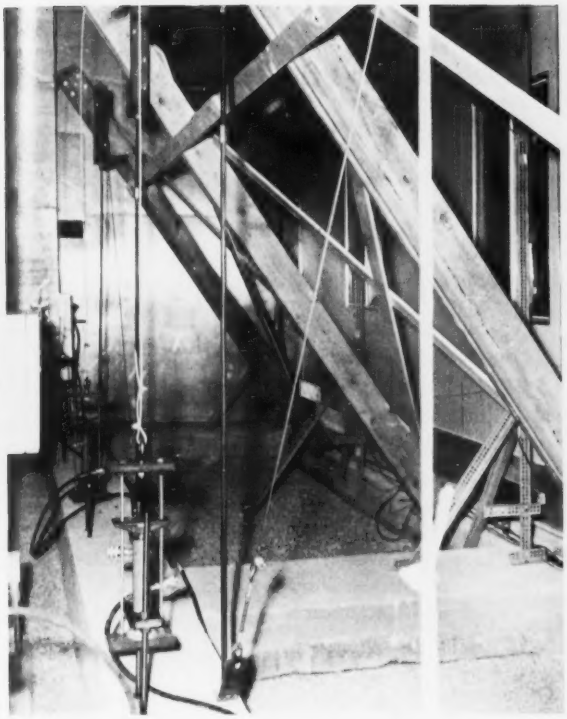
A Prefabricated Building Has Been Erected in the large environmental test chamber of the Bureau's Building Research Division at Gaithersburg, Md., to evaluate its performance. The Navy is considering this building for use as an advance-base, relocatable structure.

This prefabricated building is constructed of modular sandwich panels on an aluminum I-beam foundation. The panels are made of sheet aluminum bonded to kraft paper-honeycomb cores.

Some of the various tests being run on this building include air leakage, wind load, snow load, and heat loss. In the chamber almost all climatic conditions can be artificially simulated. The temperature can be controlled from −50 to 150 °F and the relative humidity can be controlled from 10 to 90 percent.

The building's foundation of aluminum I-beams were anchored to concrete footings for test purposes. The floor panels are aluminum and paper-honeycomb sandwiches 3 in thick, 4 ft wide, and 21 ft long.

The wall panels are 3 in thick, 4 ft wide, and 8 ft 6 in high, and weigh about 40 lb. As T. W. Reichard of NBS places a wall panel, Paul Dettor of the Navy "soaps" the rigid vinyl cleat, which slides between the panels.



Transverse loading equipment mounted on concrete footings outside the building are used in racking tests to simulate wind loads.

Smoke leaking from the building indicates the source of air leakage.

The finished interior of this prefabricated building is 20 by 32 ft.

CONFERENCE & PUBLICATION Briefs

PRECOORDINATION—THE BASIS FOR INDUSTRIALIZED BUILDING

The Bureau will host the Conference, Precoordination—The Basis for Industrialized Building, at its Gaithersburg, Md., laboratories September 24 to 26, 1969. The purpose of the Conference is to determine the Nation's requirements for standards that will foster greater efficiency in the assembly of buildings. The Conference is being presented by the USA Standards Institute Committee on Pre-Coordination of Building Components and Systems, A62. This Committee is sponsored by NBS, which furnishes the secretariat and technical support.

Specifically, the Conference will deal with basic standards that are prerequisites for achieving an industrial-type assembly of buildings without on-site modification using precoordinated interchangeable parts, components, and systems.

Standardization requirements will be explored in the area of dimensional coordination (including modular coordination), functional (or performance) coordination, and communication coordination. Emphasis will be on standards to which component design, building design, and building assembly may be independently coordinated.

USASI Committee A62 is the recognized forum of the United States building industry charged with developing the guidelines and standards that are required for a comprehensive, open system of coordination. Standards under development by A62 provide for both functional and dimensional compatibility and interchangeability of building components, systems, and design criteria. The intent is to make a common basis of coordination available to the building industry for its use.

For further information, preliminary programs, and registration forms, write to:

R. W. Smith, Jr.
Rm. B228, Building Research
National Bureau of Standards
Washington, D.C. 20234

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

Conference on Crystal Growth. Aug. 11–13. Sponsor: American Committee for Crystal Growth. Contact: C. S. Sahagian, Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass. 01730.

Precoordination—The Basis for Industrialized Building. Sept. 24–26. Sponsor: USA Standards Institute Committee A62. Contact: R. W. Smith, Jr. (NBS Building Research Division).

Dental Research—50th Anniversary. Oct. 6–8. Cosponsor: American Dental Association. Contact: G. R. Dickson (NBS Polymers Division).

3d Materials Research Symposium—Electronic Density of States. Nov. 3–6. Contact: H. C. Burnett (NBS Metallurgy Division).

AIRCRAFT INTERIOR MATERIALS

Smoke and Gases Produced by Burning Aircraft Interior Materials,[1] by D. Gross, J. J. Loftus, T. G. Lee, and V. E. Gray, NBS Building Science Series 18 (27 pages, 35 cents), was prepared to provide technical data for further defining fire safety standards—a need brought about by the development of new materials and test methods. Measurements of the smoke produced during both flaming and smoldering conditions of 141 aircraft interior materials are reported. Measurement values are in terms of specific optical density, a dimensionless attenuation coefficient that defines the photometric obscuration produced by the smoke from a specimen of given thickness and unit surface area within a chamber of unit volume.

NBS PUBLICATIONS 1966–1967

Publications of the National Bureau of Standards 1966–1967, NBS Special Publication 305 (213 pages, $2), supplements earlier publications[2] that list all published work of Bureau authors. Each title is accompanied by complete bibliographic information, a list of key words, and an abstract. Information in the catalog is accessible through two indexes: an author index and a key-word index. In addition, there is information on the NBS publishing program, purchase procedures, publication announcement services, and price lists.

VARIATIONS IN ANALYSES AND TESTS OF PORTLAND CEMENT

Causes of Variation in Chemical Analyses and Physical Tests of Portland Cement, by B. L. Bean and J. R.

D e, NBS Building Science Series 17[1] (30 pages, 40 cents), reports results of comparative tests of portland cements that all too frequently exhibit variations that could lead to uneconomical rejection of a material fully conforming to specification or, just as easily, to the acceptance of a material that fails to meet the specification. This is due largely to the fact that a great many steps are involved in making the standard chemical analyses and physical tests, and that the results are sometimes sensitive to seemingly minor variations in equipment and procedures.

This publication describes many of the factors that may be responsible for variation in chemical analyses and physical tests and suggests remedies for some of the more frequently encountered deficiencies in apparatus or methods. Emphasis is on those factors that have not been examined in sufficient detail in the previous literature of cement testing procedures. A guide to that literature is presented in the form of a list of references.

CEMENT AND CONCRETE PROPERTIES, PART 4

Interrelations between Cement and Concrete Properties, Part 4, by R. L. Blaine, H. T. Arni, and D. N. Evans, NBS Building Science Series 15[1] (77 pages, 75 cents), is a report on the drying shrinkage of portland cements. Previous reports have emphasized the effects of fineness, tricalcium aluminate, gypsum, and the alkalies on drying shrinkage, but have said little on the effects of other composition differences or on the effects of trace elements.

The first section reports on the relationship between cement properties and drying shrinkage of partially hydrated cement pastes. These were normal consistency pastes prepared from a large number of portland cements of varying types and compositions. The second section gives information on the degree of correlation of shrinkage between neat pastes and concretes. In both sections, results are analyzed by fitting multivariate regression equations with the aid of a digital computer.

NUCLEAR STANDARDS FOR CHEMISTRY AND TECHNOLOGY

Nuclear Standards for Chemistry and Technology, NBS Special Publication 310[1] (256 pages, $1.25), edited by H. F. Beeghly, J. P. Cali, and W. W. Meinke, is based on a symposium that brought together the majority of national and international groups engaged in developing the nuclear standards. The continuing growth of the nuclear power industry has highlighted the need for specific engineering and materials standards, and for reliable methods of making meaningful measurements of burn-up, fall out, atmospheric contamination, and radiation effects on materials. Equally important are standards for monitoring and for accurately measuring radiation in chemical processing, medicine, and research.

The meeting identified the problems, discussed present programs, and outlined future needs with regard to standards for nuclear technology. Standards were defined very broadly to include standard materials, standard procedures, standard specifications, standard data, and engineering standards. The mechanisms available for standardization, the state of the art in standardization in many areas of the nuclear field, a number of unmet needs, and estimates of future needs were examined in the lectures and panel discussions. These papers and discussion summaries make up the substance of this report on the symposium proceedings.

HOMOGENEITY OF SPECTROMETRIC STANDARDS

Standard Reference Materials: Homogeneity Characterization of NBS Spectrometric Standards IV: Preparation and Microprobe Characterization of W–20 percent Mo Alloy Fabricated by Powder Metallurgical Methods, NBS Special Publication 260–16[1] (24 pages, 35 cents), by H. Yakowitz, R. E. Michaelis, and D. L. Vieth, describes the preparation and evaluation of the first NBS standard reference material (SRM) tested specifically from the beginning for application to electron probe microanalyzers.

The purpose for preparing the SRM in this manner was an attempt to solve a serious problem facing the Bureau's SRM program, which is providing standards of suitable homogeneity for use with such microanalytical techniques as the spark source mass spectrograph and the electron probe microanalyzer.

The standard, SRM 480, is a tungsten 20-weight percent molybdenum alloy prepared by a powder metallurgy process, an approach that offers many advantages in the preparation of high-homogeneity metal SRM's.

Based on the results of about 1500 determinations for both tungsten and molybdenum by electron probe microanalysis, the material was found to be of high homogeneity at about the micrometer (10^{-6} meter) level of spatial resolution. The coefficient of variation for molybdenum was 2.5 percent and that for tungsten was 1.5 percent. Correction of relative intensity ratios to obtain concentrations is discussed in terms of input parameter uncertainties such as mass absorption coefficients and electron backscatter factors. Corrections are also given for atomic number and effects of operating voltage. SRM 480 should be a valuable addition to any microprobe labboratory doing quantitative analyses.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

[2] NBS Spec. Publ. 305 and the following publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the prices indicated: **Publications of the NBS 1901 to June 30, 1947,** NBS Circ. 460 ($1.25); **Publications of the NBS July 1, 1947 to June 30, 1957,** Supplement to NBS Circ. 460 ($1.50); **Publications of the NBS July 1, 1957 to June 30, 1960,** NBS Misc. Publ. 240 ($2.25); **Publications of the NBS July 1960 through June 1966,** Supplement to NBS Misc. Publ. 240 ($4).

352-403 O - 69 - 2

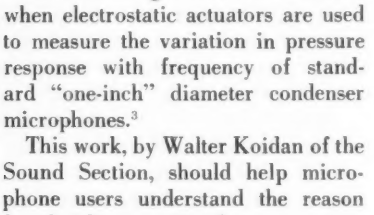
ERROR IN ELECTROSTATIC ACTUATOR CALIBRATION OF CONDENSER MICROPHONES

THE ELECTROSTATIC ACTUATOR TECHNIQUE for calibrating microphones is widely used to avoid the more time-consuming, but more accurate, methods [1] employed by laboratories devoted to precise calibration work. A recent study [2] at the NBS Institute for Basic Standards has shown that large inaccuracies result when electrostatic actuators are used to measure the variation in pressure response with frequency of standard "one-inch" diameter condenser microphones.[3]

This work, by Walter Koidan of the Sound Section, should help microphone users understand the reason for the discrepancies between actuator calibrations and the Bureau's test calibrations. It was also pointed out in the study that the errors can affect calculations of free-field responses of microphones when based on actuator calibrations.

Sound Measurements

The transducing elements of a condenser microphone used to measure sound pressure consist of a very thin metal diaphragm that is exposed to to the sound wave and a rigid metal backplate located a small distance behind the diaphragm. Variations in pressure cause the diaphragm to move, resulting in a change in electrical capacitance between diaphragm and backplate. This variation in capacitance is converted to a voltage by suitable instrumentation.



For a type L laboratory standard microphone without a recess, the actuator-determined response level minus the pressure (coupler) response level shows deviation above 1 kHz, indicating the error in the actuator calibration procedure.

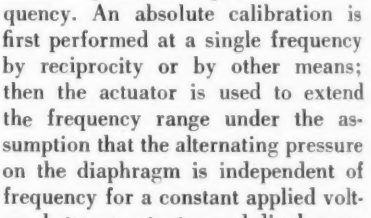
Calibration

Calibrating a microphone[4] consists of determining its response (sensitivity) in terms of the output voltage, e, across a specified electrical load divided by the applied sound pressure, p. Several kinds of responses are defined: the term "pressure response" is used when p is a uniform sound pressure over the exposed surface of the diaphragm; the phrase "free-field response" is used when p is the sound pressure in an undisturbed, plane-progressive wave.

The most accurate method known for the pressure calibration of condenser microphones over a wide frequency range is the reciprocity technique.[1] This method makes use of an acoustic coupler consisting of a small, closed cavity having a volume of about 3 to 20 cm^3 depending on the frequency range to be covered. The diaphragms of two microphones form part of the walls of the cavity. In a calibration, three microphones are used in pairs with one microphone as a sound source and the other as a sound receptor. This procedure yields the response e/p of each microphone.

Calibration by the electrostatic actuator [5] method consists of placing a metal grid in front of the diaphragm of a microphone and applying two voltages between the grid and diaphragm: a dc bias voltage and an alternating voltage at the frequency of interest. The resultant electrostatic forces move the diaphragm at the frequency of the alternating voltage just as if a sound pressure were applied.

In current practice, actuators are usually used only to estimate the variation in pressure response with frequency. An absolute calibration is first performed at a single frequency by reciprocity or by other means; then the actuator is used to extend the frequency range under the assumption that the alternating pressure on the diaphragm is independent of frequency for a constant applied voltage between actuator and diaphragm. It is this assumption that leads to large errors in actuator calibration work.



These plots show the effect of acoustic loading on diaphragm motion relative to motion into a quarter wavelength tube: effect of radiation impedance or free space (dots); effect of modified radiation impedance (dashed line); and effect of grid and quarter wavelength tube (solid line).

The study showed experimentally that the net pressure on the diaphragm is not the same as the applied electrostatic pressure but is equal to the electrostatic pressure minus the presure drop across the diaphragm radiation impedance in the presence of the actuator (modified radiation impedance). The pressure drop, which is caused by the motion of the diaphragm, varies with frequency. The resulting inaccuracy becomes apparent at about 2 kHz and increases with frequency.

Radiation Impedance Studies

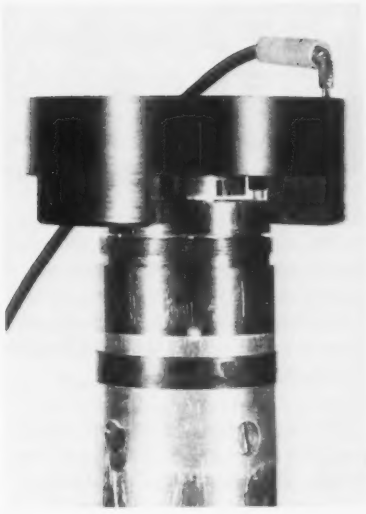
To verify that the error in an electrostatic actuator calibration is due mainly to the pressure drop across the modified radiation impedance, two types of experiments were performed.

In one experiment, an actuator calibration was carried out with a quarter-wavelength tube in front of the diaphragm-actuator combination. The tube was of adjustable length and had a rigid termination, so that the acoustic impedance seen by the diaphragm could be reduced to a very low value over a wide range of frequencies. With this arrangement, coupler calibration and actuator calibration agreed to within 0.15 dB up to 15 kHz for an actuator 0.021 in thick.

In a radically different experiment, the microphone was driven electrically between backplate and diaphragm (rather than acoustically). Simultaneously the magnitude of the diaphragm displacement was measured with the aid of a carrier-frequency circuit.[6] This was repeated for several acoustic loads, including a quarter-wavelength tube closed at the far end, free space, electrostatic actuators, and actuator-quarter-wavelength tube combinations.

The results of this experiment show the effects on diaphragm motion of the various acoustic loads relative to a zero load. Since diaphragm motion is similar whether the microphone is driven from backplate or actuator, the experiment also measures the errors that occur in an actuator calibration.

A view from above the electrostatic actuator shows the grille structure.



A side view shows the air gap between actuator and microphone diaphragm.

Free-Field Calibration

Actuator calibrations are often erroneously referred to as pressure calibrations. If the microphone user is not aware of the fact that an actuator calibration does not yield a true pressure response, errors can result in the calculation of free-field response when the conversion values given in Table A1 of USA Standard S1.10 are used. This table lists the differences between free-field response levels and pressure response levels for the most frequently used "one-inch" laboratory standard condenser microphones. The table is not applicable to electrostatic-actuator calibrations.

Application to Small Microphones

Very little has been done as yet on the comparison of actuator and coupler calibrations for small condenser microphones (diameters of ½ in or less). It is likely that if accurate work were carried out, it would be found that better agreement would be obtained for the smaller than for the larger microphones since the acoustic driving-point impedance of the smaller units is considerably greater than that of the one-inch units and the modified radiation impedance relatively less important.

[1] USA Standard S1.10–1966, Calibration of Microphones (USA Standards Institute, New York, 1966).

[2] Koidan, W., Calibration of standard condenser microphones: Coupler versus electrostatic actuator, J. Acoust. Soc. Am. **44**, No. 5, 1451–1453 (Nov. 1968).

[3] USA Standard S1.12–1967, Specifications for Laboratory Standard Microphones (USA Standards Institute, New York, 1967).

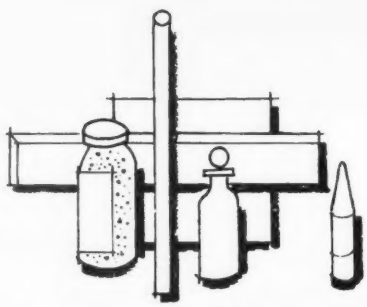
[4] Calibration of microphones, NBS Tech. News Bull. **45**, 188–191 (Nov. 1961).

[5] Beranek, L., Acoustic Measurements (John Wiley & Sons, New York, N.Y., 1949).

[6] Koidan, W., The condenser microphone as a displacement detector calibrator, J. Acoust. Soc. Am. **29**, No. 7, 813–816 (July 1957).

NOTE: Additional NBS work on microphone calibration is described in: Accurate Coupler Calibration of Microphones at High Frequencies, NBS Tech. News Bull. **47**, 76–77 (May 1963).

STANDARD REFERENCE MATERIALS



Standard Reference Materials are well-characterized materials certified for chemical composition or for a particular physical or chemical property. These materials are disseminated by NBS [1] to be used to calibrate and evaluate measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base.

Six new standard reference materials (SRM's) are now available from the NBS Office of Standard Reference Materials. They are a clinical standard, two steel standards, a rubber standard, a vapor pressure standard, and a mass spectrometric standard.

CLINICAL STANDARD

A very high-purity calcium carbonate standard reference material has been produced and certified for use in all clinical laboratory determinations for calcium. SRM 915, Calcium Carbonate, is the fifth [2,3] in the series of clinical SRM's and was prepared at the request of the American Association of Clinical Chemists and the College of American Pathologists, which stressed the need for the certification and issuance of such a standard.

Calcium Carbonate

The rapid and accurate analysis of calcium in serum is an important clinical test. Hypercalcemia, when supported by other clinical evidence, is often indicative of hyperparathyroidism, and medical decisions involving immediate surgery are often made on the basis of the serum calcium value. The imperative need for accurate calcium determinations is obvious.

In clinical procedures calcium is determined usually as a calcium-fluorescent complex by fluorometry, by flame emission, or by atomic absorption methods. The NBS calcium carbonate will serve as the primary standard for the calibration of the instruments and methods used.

The calcium carbonate now certified as an NBS–SRM was produced in a special run by the J. T. Baker Chemical Co., Phillipsburg, N.J. Although certified at only 99.9+ percent purity at this time, analyses now underway at NBS indicate that the purity is in fact in excess of 99.99 percent.

The material was examined for compliance with the specifications for reagent-grade calcium carbonate as given in *Reagent Chemicals* (4th ed.) published by the American Chemical Society. The material was found to meet or exceed the minimum requirements in every respect. Examination by thermal gravimetric analysis indicated a minute loss of weight below 175 °C (volatile matter) and a stable composition up to a temperature of 625 °C, above which decomposition (evolution of CO_2) set in.

Replicate samples taken from a randomly selected region of the undried material were assayed by a coulometric acidimetric procedure. The results from nine independent determinations, based on expression of the assay as calcium carbonate, indicate a purity of 99.99+ percent with a standard deviation of 0.003 percent. Samples equilibrated at a relative humidity of 90 percent and assayed by this coulometric procedure showed a maximum moisture absorption of 0.02 percent as compared to samples that were dried for 6 hours at 210 °C. The moisture content on samples equilibrated at 75 percent relative humidity was found to be 0.01 percent.

A semiquantitative survey for trace contaminants by emission spectroscopy indicated the presence of less than 0.001 percent copper, iron, magnesium, manganese, and silicon in the material. By atomic absorption, magnesium was evaluated at 1.0, sodium at 0.4, and strontium at 2.1 parts per million; potassium was less than 0.4, lithium less than 0.05, and barium much less than 10 parts per million. Neutron activation analysis indicated copper to be 0.9, manganese to be 0.6, and sodium to be 0.5 parts per million. Copper was determined at 1 part per million by spectrophotometry.

SRM 915 is packaged in units of approximately 20 g and is priced at $25 per unit.[4]

STEEL STANDARDS

Two additional oxygen-in-steel reference materials have been issued with Provisional Certificates. With their issuance, five such materials have now been issued with Provisional Certificates. Supplemental information on the nitrogen content of these materials has been included.

The role of oxygen and nitrogen as they affect the basic properties of metals, e.g., brittleness, ductility, etc., is well established. A maraging steel can be produced that is dimensionally stable; however, oxygen present as inclusions affect this stability, particularly at high pressures. It is therefore important that SRM's be available with known oxygen and nitrogen content to calibrate the various instruments or methods now used to determine these gases. Neither the oxygen nor the nitrogen content of any of these materials has been certified at this time; however,

the values given are believed to be sufficiently accurate for making practical calibrations.

The new standards are SRM 1093, Oxygen in Valve Steel, and SRM 1094, Oxygen in Maraging Steel. The other standards: SRM 1090, Oxygen in Ingot Iron; SRM 1091, Oxygen in Stainless Steel (AISI 431); and SRM 1092, Oxygen in Vacuum Melted Steel, have Revised Certificates of Analyses that give oxygen values obtained by neutron activation and inert gas fusion in addition to the values obtained by vacuum fusion.

All of these SRM's are rods 4 in (10.2 cm) long, of which four are ¼ in (6 mm) in diameter, while SRM 1091 is 5/16 in (8 mm) in diameter. Each is priced at $50 per unit.[4]

Oxygen in Valve Steel

SRM 1093, oxygen in valve steel, which has values of 60 ppm with an uncertainty of 5 ppm for oxygen and about 4807 ppm for nitrogen, is intended primarily for use as a standard for the neutron activation method for determining oxygen in steel. The oxygen was determined in a 2-in length of rod, which had been cleaned ultrasonically in trichloroethylene and then dried in dry nitrogen. The rods were activated, together with standards of known oxygen concentration, in the NBS 14-MeV neutron generator. The nitrogen-16 (7.2 s half life), formed from the nuclear reaction $^{16}O(n, p)^{16}N$, was counted and the induced radioactivity was compared to that of the irradiated standard.[5–7]

The determination of oxygen in this particular steel by vacuum or inert gas fusion is difficult because of the gettering action of the manganese, which is of the order of 9 to 10 percent.

Oxygen in Maraging Steel

SRM 1094, oxygen in maraging steel, is intended primarily for application in vacuum and inert gas fusion methods for the determination of oxygen. The low value of oxygen, about 4 ppm, makes determination by neutron activation difficult. Present configuration of the neutron generator precludes an accurate determination of oxygen at this level. Redesign of the equipment to increase the sensitivity of the technique at these low levels is now underway at NBS.

The vacuum fusion oxygen value is the result of 109 determinations on 32 samples of the standard. One gram samples were carefully cut from the rod material, cleaned, washed, and dried. A furnace temperature of 1675 °C and a vacuum of $<10^{-5}$ torr were maintained during the 4-min collection time from a high-purity nickel bath.

Nitrogen Content

For SRM 1093, the nitrogen content was found to be about 4807 ppm by a pressure bomb-distillation-indophenol-titrimetric method and about 3640 ppm by the vacuum fusion technique, with the higher value believed to be more accurate. For SRM 1094, the nitrogen content was found to be about 71 ppm by the pressure bomb-distillation-indophenol-photometric method and about 61 ppm by the vacuum fusion technique.

From the nitrogen results on both SRM's, it is apparent that systematic biases exist in one and possibly all of the methods used. There also is evidence that these results are material dependent. The complexity and magnitude of this dependence effect is not known. A comprehensive research effort is now underway to resolve this question and to determine other possible systematic errors. When this research is completed, these standards will be certified for their nitrogen content.

Acrylonitrile-Butadiene Rubber

For many years NBS has made available rubbers and other materials for rubber-compounding. Those currently supplied are natural rubber (NR), two types of styrene-butadiene rubber (SBR), and butyl rubber (IIR). A new rubber has recently been added to this group—acrylonitrile-butadiene rubber (NBR).

Acrylonitrile-butadiene rubber is resistant to deterioration by oil, gasoline, and other hydrocarbon products. Standard Reference Material 391 is for use in the quality control of the manufacture of this rubber.

SRM 391 contains approximately 33 percent combined acrylonitrile. The uniformity of the lot was established by tests on samples taken after each tenth package during manufacture. The Mooney viscosity of this rubber was determined to be 49.0 with an uncertainty of 1.0 ML 1+ 4 (100 °C) using a modification of ASTM Designation D1646–68.

SRM 391 is sold for $100 per package of 25 kg.[4]

Gold

The Bureau has established gold as a vapor pressure standard reference material. The vapor pressure of 99.999+ percent pure gold has been accurately determined over the pressure range 10^{-3} to 10^{-8} atmospheres (1.013×10^{2} to 1.013×10^{-3} N/m^2) and over the temperature range 1300–2100 K. Gold is the first in a series of elements to be certified for vapor pressure measurements in this pressure range. The complete series, now underway, will cover a temperature range of 600 to 3000 K.

SRM 745 should be of particular interest to laboratories making high-temperature vapor pressure measurements using the Knudsen, torque Knudsen, or mass spectrometric techniques.

As it is not uncommon for vapor pressure measurements made by experienced investigators to differ by 30, 50, or even 100 percent, there is a definite need for high-temperature vapor pressure standards. SRM 745 was developed for use in testing and calibrating vapor-pressure measurement apparatus and techniques, and in detecting possible systematic errors. SRM 745 can also be used for direct interlaboratory comparisons.

A statistical analysis based on the experience of eight cooperating laboratories has resulted in an estimate of uncertainties expected in the measurement of vapor pressure-temperature curves. Evaluation of uncertainties was made for (1) the scatter of points about the curve, (2) the slope of the curve, and (3) the absolute value of the vapor pressures.

Homogeneity of SRM 745 has been established by extensive testing at NBS. It is sold in the form of wire 1.4 mm (0.055 in) in diameter and 152 mm (6 in) long, for $80 per unit.[4]

Enriched Boric Acid

SRM 952, 95 percent boron–10 boric acid, supplements SRM 951, normal boric acid, and will provide material for the calibration of mass spectrometers at the 95 percent boron–10 level. SRM 952 is available in units containing 0.25 g of boric acid and is sold for $35 per unit.[4]

SRM 952 has an absolute abundance ratio of $^{10}B/^{11}B$ of 18.80, and an acidimetric assay of 99.97 percent. It is useful as a "spiking" material for the determination of boron by isotopic dilution, as well as its use for the calibration of mass spectrometers.

Many of the power reactors contain control systems involving boron, so SRM 952 should be particularly useful in the nuclear power field and in the determination of "trace element levels" in the ferrous metals and agricultural fields.

[1] For a complete list of Standard Reference Materials available from NBS, see **Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards,** NBS Misc. Publ. 260 (1968 ed.) for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 45 cents. Quarterly insert sheets that update Misc. Publ. 260, are supplied to users on request.

[2] **Standard Reference Materials,** Certified Purity Cholesterol, Nat. Bur. Stand. (U.S.), Tech. News Bull. **52,** No. 1, 16 (Jan. 1968).

[3] **Standard Reference Materials,** Clinical and Biomedical Standards, Nat. Bur. Stand. (U.S.), Tech. News Bull. **53,** No. 4, 92–94 (April 1969).

[4] This standard may be purchased for the price indicated from the Office of Standard Reference Materials, Rm. B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20234.

[5] Nargolwalla, S. S., Crambes, M. R., and DeVoe, J. R., Anal. Chem. **40,** 666 (1968).

[6] Lundgren, F. A., and Nargolwalla, S. S., Anal. Chem. **40,** 672 (1968).

[7] Nargolwalla, S. S., Przybylowicz, E. P., Suddueth, J. E., and Birkhead, S. L., Anal. Chem. **41,** 168 (1969).

DENSITY DATA ON CRYOGENIC FLUIDS

In Recent Years, Practical Applications involving cryogenic fluids have expanded greatly. Today sale and transfer of liquefied gases for industrial and aerospace purposes has became a multimillion-dollar business.

With this widespread commerce in cryogenic fluids, a need has developed for extensive and accurate values for the physical properties of many of the important cryogenic liquids. Such information is needed, since a certain amount of nonuniformity in costs and billings arises when different suppliers use slightly different methods of values during the metering and transfer process.

In response to this need, standard density data for the saturated liquid of four commercially-important gases [1]—oxygen, nitrogen, argon, and parahydrogen—have been compiled by H. M. Roder, R. D. McCarty, and V. J. Johnson of the NBS Institute for Basic Standards' Cryogenics Division, Boulder, Colo. These data were prepared at the specific request of users such as the Compressed Gas Association, the Department of the Air Force, the National Aeronautics and Space Administration, and the State of California, which must either pay for delivery of liquefied gases or supervise delivery to customers. To date, the State of California has incorporated extracted tables in its code (law) for cryogenic measuring devices, and uses the report to provide traceability to NBS. In addition, the Compressed Gas Association is reissuing its service Pamphlet P-6, "Standard Density Data, Atmospheric Gases and Hydrogen," using the NBS values as the data base.

Included in the data presentation are integrated tables of pressure, volume, and temperature for the saturated liquid, from the triple point to the critical point of oxygen, nitrogen, argon, and parahydrogen. The tables include entries of integral values of pressure in both atmospheres and pounds per square inch (absolute). Volumes and densities in three different units and a density ratio are tabulated for each entry.

The NBS Cryogenic Data Center was asked to provide the data, because it had prepared major compilations on oxygen, nitrogen, argon, and parahydrogen from which standard density data could be derived. Each of these compilations presents a consistent set of values from a single source for each fluid, and each of the sources is considered to be the best available today. All available data, in particular the correlation of the single phase PVT data with the saturation boundaries and the vapor pressure curve, have been taken into consideration. The equations of state, in the form of computer programs, allow determination of values, both at liquid temperatures and at room temperature. The equations of state present a consistent set of values for the saturation boundary as well as for the compressed fluid states.

As flowmeter technology improves, an extension to the compressed fluid state will definitely be required. Such a change can be accomplished without further adjustment in the numerical values. Thus, it is estimated that the values presented will serve as the basic guidelines for some time to come.

[1] Roder, H. M., McCarty, R. D., and Johnson, V. J., **Saturated Liquid Densities of Oxygen, Nitrogen, Argon, and Parahydrogen,** NBS Tech Note 361 (January 1968).

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

Gaseous Ions

The latest publication in the NSRDS series is NSRDS NBS-26, *Ionization Potentials, Appearance Potentials and Heats of Formation of Gaseous Positive Ions*[1] ($1.25), by J. L. Franklin and J. G. Dillard, Rice University; H. M. Rosenstock, J. T. Herron, and K. Draxl, NBS Institute for Materials Research; and F. H. Field, Esso Research and Engineering Company. Since the publication of *Electron Impact Phenomena*, by F. H. Field and J. L. Franklin, a compilation of ionization and appearance potentials reported through 1955, the study of gaseous ionization phenomena has undergone an explosive growth in the number and variety of pertinent research studies. This field now includes aspects of vacuum ultraviolet spectroscopy, inelastic electron scattering, photoionization, photoelectron spectroscopy, mass spectrometry, charge exchange, and theoretical chemistry.

The present volume covers the literature published since 1955. It presents essentially all the values of appearance potentials of positive ions obtained since 1955, provides a set of "best" values of heats of formation of gaseous ions, and serves as a guide to the literature.

The heart of this work is a table that gives ionization potentials, appearance potentials, probable mechanisms, the method by which the data were obtained, and computed heats of formation of the various positive ions. The order of presentation of the ions is that of increasing atomic number (except for the rare gases, which are given together) and molecular complexity.

For each ion, the various processes of ion formation are arranged in order of increasing complexity, and for each order of complexity, in order of decreasing reliability of method. Thus direct ionization processes are given before fragmentation processes, and spectroscopic measurements before electron impact measurements.

The mechanisms listed are normally, but not necessarily, those given in the original paper. Where more than one neutral product is proposed, the compilers have normally considered the mechanism to be too speculative to warrant using the resulting heat of formation in arriving at a "best" value. Appearance potentials are given along with the investigator's estimate of the precision of their measurements.

The method of measurement is indicated in an abbreviated form in addition to each appearance potential. Also included is a table that lists the abbreviations, their meaning, and at least one reference in which the method is discussed in some detail. Theoretical calculations are included for completeness. The table also includes an estimate of the reliability of the methods, which receives further discussion in the text.

In some instances where the heat of formation of the ion is well established but that of either the reactant or the product of the neutral species is not, the compilers have computed the heat of formation of the neutral ion. The heats of formation of the neutral ions thus determined are collected for convenience in tabular form.

Finally, for each appearance potential given in the tables, a numerical reference to the bibliography of appearance potentials is listed. This bibliography includes more than 700 references through 1966. An author index is also included.

Chemical Thermodynamic Properties

NBS Technical Note 270–4, *Selected Values of Chemical Thermodynamic Properties, Tables for Elements 35 Through 53 in the Standard Order of Arrangement*[1] ($1.25), by D. D. Wagman, W. H. Evans, V. B. Parker, I. Halow, S. M. Bailey, and R. H. Schumm, is the fourth in a series of Notes containing the tables of numerical values prepared as a revision of NBS Circular 500, *Selected Values of Chemical Thermodynamic Properties.*

This Note contains data for compounds of mercury, copper, silver, gold, nickel, cobalt, iron, palladium, rhodium, ruthenium, platinum, iridium, osmium, manganese, technetium, rhenium, chromium, molybdenum, and tung-

sten. The tables contain values, where known, of enthalpy and Gibbs energy of formation, enthalpy, entropy, and heat capacity at 298.15 K (25 °C), and the enthalpy of formation at 0 K, for all inorganic substances and organic molecules containing not more than two carbon atoms. These tables do not cover metal alloys or other solid solutions, fused salts, or substances of undefined chemical composition.

All of the values given in these tables have been calculated from the original articles using consistent values for all subsidiary and auxiliary quantities. The original data were corrected where possible for differences in energy units, molecular weights, temperature scales, etc. The authors thus have sought to maintain a uniform scale of energies for all the substances in the tables. Further, the tabulated values of the properties of a substance satisfy all the known physical and thermodynamic relationships among these properties. The quantities $\Delta Hf°$, $\Delta Gf°$, and $S°$ at 298.15 K satisfy the relation:

$$\Delta Gf° = \Delta Hf° - T\Delta Sf°.$$

Technical Note 270-4 contains an appendix listing corrections for errors and misprints detected in the previously published Technical Note 270-3 [1] ($1.25), which contains tables of data for compounds of elements numbered 1 through 34 in the standard order of arrangement.

As additional revised tables of Circular 500 are completed, they will be published in the Technical Note 270 series because of the urgent need for the data. After all tables have been revised they will be combined with a description of the evaluation process and a listing of the sources of the data into a single publication that will be a part of the NSRDS series of critically evaluated compilations.

Ion-Molecule Reactions

Ion-Molecule Reactions is the title of the first critical review on this subject to be issued by the Atomic and Molecular Processes Information Center at Oak Ridge National Laboratory, Oak Ridge, Tenn., and is scheduled for publication during July by John Wiley and Sons. The authors are E. W. McDaniel, A. Dalgarno, V. Cermak, E. E. Ferguson, and L. Friedman.

Approximately half of this volume discusses the state of the art of the known experimental methods for making quantitative studies of ion-molecule reactions in the gaseous phase, and critically analyzes the accuracy and reliability of these methods. Next, the theoretical foundations of the subject and the various models adopted in the computations of reaction rates are covered. The measurements in the earth's atmosphere from which information on ion-molecule reactions have been deduced are reviewed. This is followed by a discussion of ion-molecule chemistry. Finally, experimental data on approximately 200 ion-molecule reactions are displayed in tabular and graphical form. All of the available data on these reactions were critically analyzed, and the best values included. In many cases where more than one good measurement appears to have been made on a given reaction, several values are presented to indicate the magnitude of the disagreements among the separate results.

Radiation Chemistry Bibliographies

The Radiation Chemistry Data Center, Radiation Laboratory of the University of Notre Dame, a joint NSRDS-AEC Data Center, has issued three bibliographies. The first, *Bibliography on the Radiation Chemistry of Alcohols and Phenols*, covers the literature from 1953 to 1968. A compound index is included. The second is *Bibliography on the Radiation Chemistry of Aqueous Solutions I, Amino Acids 1952–1968*, and the third is *Bibliography on the Radiation Chemistry of Aqueous Solutions II, Carbohydrates 1952–1968*. All three include abstract references for foreign language articles and technical reports, while the latter two also contain author indexes. A fourth, *Bibliography on the Radiation Chemistry of Alkanes*, is in press. These bibliographies are available from the Radiation Chemistry Data Center, Radiation Laboratory, University of Notre Dame, Notre Dame, Ind., 46556.

Gordon Conference on Numerical Data

The Gordon Conference on Numerical Data of Science and Technology will be held July 21–25, 1969, at Tilten, N.H., with N. B. Gove as Chairman and R. Hultgren as Vice Chairman. The program includes the following panels and panelists: "Transport properties," Y. S. Touloukian, Chairman, J. Ferran, M. Klein, J. R. Manning, R. W. Powell, and S. C. Saxena; "Thermodynamics of Phases of Variable Composition," R. Hultgren, Chairman, L. Eyring and J. Elliot; "Computer Systems: What we Have," J. Hilsenrath, Chairman, D. W. Cardwell, F. L. Alt, R. R. Wigington, and B. C. Duncan; "Computer Systems: What We Need," D. W. Cardwell, Chairman, O. Kennard, J. Hilsenrath, and D. R. Stull; "Nuclear Data," D. T. Goldman, Chairman, C. M. Lederer and M. Drake; "Can We Achieve Reliability in Data Compiling," L. J. Kieffer; "Thermal and Kinetic Data," D. L. Stull, Chairman, R. H. Harrison, W. A. Evans, and E. K. Storms. Some special topics and sessions include: "The Scientific Vocabulary," with N. B. Gove as Chairman and P. B. Gove as speaker; "Fundamental Constants," E. R. Cohn; "Report on CODATA," C. Schafer; and "Report on NSRDS," D. R. Lide, Jr.

Organic Magnetic Resonance

A new international journal entitled *OMR-Organic Magnetic Resonance*, is being published by Heyden & Sons Ltd., London, England. This journal is devoted specifically to all branches of magnetic resonance as applied in the field of organic chemistry and will include papers on NMR, NQR, EST, and the more recently developed tech-

nique of ion cyclotron resonance (ICR). A novel feature of this journal is the *Spectral Supplement* in which the spectra are reproduced on a large scale, with the experimental conditions fully specified in a uniform format. Subscription information may be obtained from: OMR-Organic Magnetic Resonance, Heyden & Sons Ltd., Spectrum House, Alderton Crescent, London N.W.4, England.

[1] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

LOSS OF COLOR DISCRIMINATION UNDER REDUCED VISUAL CONDITIONS

Under Reduced Visual Conditions, small area and low luminance, color discrimination for normal eyes deteriorates in a manner similar to that observed for tritanopic vision. Tritanopic vision is characterized by an inability to discriminate between greenish-yellow and purplish-blue; the spectrum is seen only as reds and greens. This phenomenon has long been known to users of color for signaling devices, such as for railroads and lighthouses, where it is generally known that purple, blue, and yellow can not be safely used for signal lights that must be identified at a distance.

In a study [1] of this deterioration of color discrimination, by G. T. Yonemura and M. Kasuya * of the NBS Institute for Basic Standards, the relationship between area and luminance for loss of color discrimination was quantified using color-matching techniques. In addition, an empirical equation was obtained that describes the threshold of chromaticity discriminability under reduced visual conditions quite well.

In the NBS experimental determinations of color discrimination under reduced luminance and angle subtense, two observers attempted to match a two-color-mixture test target with a standard target. In all cases, the experimenter initially set the test stimulus so that there was an obvious difference of chromaticity and/or brightness between the test stimulus and the standard. The observers were required to adjust the proportions of the two light beams being mixed to match the test target's chromaticness and brightness with the standard.

The luminances of the standard used in the study were 86, 8.6, 0.86, and 0.086 cd/m^2. The diameters varied from 0.015 to 1.092 cm. The areas of the test and standard stimuli were the same for a match. The subjects had normal color vision and were experienced in color matching on the apparatus used.

A reciprocal relation was found between small target area and low luminance. That is, a target smaller than another target of the same color, could be made to be as visible as the second, if the luminance was increased by a proportional amount so that the total effective flux was constant. It was further observed that the product of the area to the three-fourths power and the luminance was a constant; or, effective flux $= \omega^{3/4}L$.

The general empirical equation for the threshold, s, of chromaticity discriminability was found to be

$$\ln s = a(\ln F)^2 + b(\ln F) + c,$$

where F is the effective flux. The constants a and b for a given color direction were similar for the two subjects, while the constant c seemed to be applicable only to a given subject. With more subjects it may be possible to obtain a useful average value of the constants a and b, which determine the rate of loss of color discrimination. Only the personal constant (c) would then be needed to describe a given subject's ability to discriminate colors of targets of small size and low luminance.

Comparison of plots for the observers going from yellowish-green to reddish-blue direction with those going from yellowish-orange to bluish-green direction indicates that the rate of color-discrimination loss is greater for the yellowish-green to reddish-blue direction relative to the yellowish-orange to bluish-green direction; that is, s increases at a faster rate in the yG-rB direction than in the yO-bG direction. Furthermore, the absolute loss (constant c) for a given level of luminous flux is larger for the yG-rB direction than for the yO-bG direction, except for the highest luminance used in the study. Both these observations indicate that the ability to match colors that lie on lines that point toward the reddish-blue corner of the chromaticity diagram suffers greater losses than for lines that point toward the red part of the chromaticity diagram. This result is consistent with the basic characteristics of tritanopic vision.

* Now with Japanese National Railroads, Tokyo, Japan.

[1] For complete details, see Yonemura, G. T., and Kasuya, M., Color discrimination under reduced angular subtense and luminance, J. Opt. Soc. Am. 59, 131 (1969).

STANDARDS AND CALIBRATION

ELECTROMAGNETIC MEASUREMENTS AND STANDARDS COURSE

An intensive two week course in Electromagnetic Measurements and Standards, to be conducted August 4 through 15 by the National Bureau of Standards at its Boulder (Colo.) laboratories, is attracting professional staff members from industry, universities, military establishments, and other Government agencies.

The NBS Institute for Basic Standards in association with the University of Colorado's Bureau of Continuation Education has designed a course to fit the needs of those whose responsibilities include precision electromagnetic measurements, standards, and quality assurance and control. Topics will include measurement techniques and standards in the high- and microwave-frequency ranges, with special emphasis on understanding and analyzing measurement techniques; theory to form a basis for such understanding and to demonstrate limitations of certain analytical tools; and applications for all measurements used by leading standards laboratories to obtain the highest precision and accuracy.

Further details and registration forms are available from:

The Bureau of Continuation Education
Rm. 328, University Memorial Center
University of Colorado
Boulder, Colo. 80302

ARKANSAS RECEIVES WEIGHTS AND MEASURES STANDARDS

Arkansas became the seventeenth State to receive new weights and measures standards under a program to replace the standards of all 50 States. The sets include standards of both the customary and metric measurement systems.

On April 18, A. V. Astin, NBS Director, presented the set to Governor Winthrop Rockefeller in a ceremony at the Weights and Measures Laboratory in Little Rock.

New standards have previously been presented to Ohio, Illinois, Oregon, Utah, California, New Mexico, Delaware, Connecticut, Tennessee, Kentucky, Hawaii, Georgia, Missouri, North Carolina, Pennsylvania, and Wisconsin.

STANDARD FREQUENCY AND TIME BROADCASTS

High frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. These NBS time signals, UTC (NBS), are maintained within 5 microseconds of the corresponding time signals of the U.S. Naval Observatory, UTC(USNO). The UTC pulses occur at intervals that are longer than one coordinate second by 300 parts in 10^{10} during 1969, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on August 1, 1969.*

The low frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on August 1, 1969.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Volume 53, No. 6, June 1969, 30 cents. Annual subscription: Domestic, $3; foreign, $4. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $9.50; foreign, $11.75. Single copy, price varies.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25.

Section C. Engineering and Instrumentation. Issued quarterly.

Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25.

CURRENT ISSUES OF THE JOURNAL OF RESEARCH

J. Res. Nat. Bur. Stand. (U.S.), 73A (*Phys. and Chem.*), No. 4 (July–Aug. 1969).

Negas, T., and Roth, R. S., Synthesis of barium ferrates in oxygen.

Negas, T., and Roth, R. S., The system SrO—"chromium oxide" in air and oxygen.

Smith, E. W., Vidal, C. R., and Cooper, J., Classical path methods in line broadening. I. The classical path approximation.

Smith, E. W., Vidal, C. R., and Cooper, J., Classical path methods in line broadening. II. Application to the Lyman series of hydrogen.

Woolley, H. W., The second virial coefficient for the realistic pair potential.

OTHER NBS PUBLICATIONS

Koeser, R. L. Ed., Report of the 53d National Conference on Weights and Measures, 1969, Nat. Bur. Stand. (U.S.), Spec. Publ. 311, 182 pages (Mar. 1969), $1.25.

LaFleur, P. D., Ed., Activation Analysis Section: Summary of activities July 1967 to June 1968, Nat Bur. Stand. (U.S.), Tech. Note 458, 109 pages (Mar. 1969), $1.

Lee, R. D., Construction and operation of a simple high-precision copper-point blackbody and furnace, Nat. Bur. Stand. (U.S.), Tech. Note 483, 16 pages (May 1969), 30 cents.

Oberholtzer, B. L., Publications of the National Bureau of Standards 1966–1967, Nat. Bur. Stand. (U.S.), Spec. Publ. 305, 220 pages (Apr. 1969), $2.

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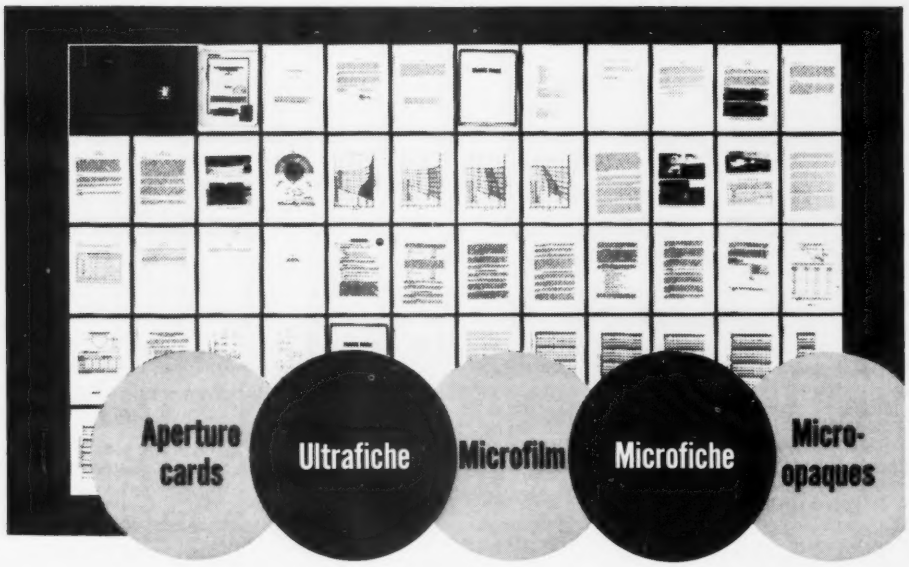

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